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notions of time-units. Houzeau took his dogs out walking every alternate day, and after ten walks did not notice a spontaneous desire of the dogs to go out, although they enjoyed the walk. The dogs did not estimate the interval, but took hints from trifling indications. They notice the return of a complex series of circumstances. On the other hand, Houzeau ascribes an instinctive time-sense to the crocodile that comes back to its eggs after a definite interval, varying from ten to fifteen days in different species. The mules on the horse-cars in New Orleans make five trips a day, and are always very restless on completing their fifth trip. Such facts need more exact experimentation before they can be ascribed to real counting on the part of the animals.

THE INFLUENCE OF SENSATIONS ON ONE ANOTHER. — Under this head Dr. Urbanschtsch of Vienna reports some curious experiments, the value of which must be left to future research to decide. His general conclusion is, that the excitation of one sense-organ increases the acuteness of the others. If a disk be regarded at such a distance that its color is indistinct, the hearing of a sound will bring out the color. The beating of a watch is heard more clearly with the eyes open than with the eyes closed. Red and green increase auditory perceptions; blue and yellow weaken them. The fact that we listen to music with our eyes closed is due to other reasons, and also to the fact that the *ensemble* appears best when the tones are not at their clearest. Smell, taste, and touch are open to the same influence. Red and green increase the sensitiveness of each of these senses; yellow and blue weaken their sensitiveness. Touch and temperature have a reciprocal influence. If one tickles the skin and plunges it into warm water, the tickling ceases; if into cold water, the tickling brings out the feeling of cold. These observations are regarded as showing the same re-enforcing action between sensations as has been shown to exist between motions, and as offering a mode of explanation of those curious associations between colors and sounds so insistent in some minds.

BOOK — REVIEWS.

Greek Life and Thought, from the Age of Alexander to the Roman Conquest. By J. P. MAHAFFY. New York, Macmillan. 12°. \$3.50.

THIS work is in the main a continuation of the author's previous volume, 'Social Life in Greece from Homer to Menander,' though somewhat wider in its scope. It lacks the absorbing interest that belongs to the history of the great days of Greece, but it has a new interest of its own in the spread of Hellenic civilization in Egypt and western Asia. The work is not confined to the moral and social life of the times, though this is the most prominent feature, but contains a great amount of information and discussion on almost every phase of Hellenic life. The political interest of the age immediately succeeding the death of Alexander centres partly in the division of his empire into various kingdoms, and partly in the struggles of the cities in European Hellas to recover their independence. Of the various kingdoms of the Hellenistic world, Egypt was, in Mr. Mahaffy's opinion, the most important and the most prosperous, — a fact which he attributes in great part to the statesmanlike genius of its founder, the first Ptolemy. In dealing with the cities of Greece, the author shows a lack of sympathy with the spirit of freedom and local patriotism which is not quite creditable in a citizen of a free country and a historian of Hellenism. It is true, the struggles of the cities to regain their autonomy proved unavailing, and perhaps they were not sufficiently cosmopolitan in their views; yet freedom is better than empire, and, while we acknowledge the defects and the failure of the patriots, we cannot but sympathize with their misfortunes.

Of the moral life of the period, we get glimpses from many points of view, and yet, as a whole, it is somewhat difficult to judge. The sins of the royal courts, especially the frequent murders, the use of torture, and the perpetual wars, are sufficiently prominent; yet Mr. Mahaffy thinks that the morality of private life was purer and more refined than it was in earlier times. In one respect there was certainly a real moral advance: it was during this period that the great schools of ethical philosophy were founded, and men came to regulate their lives by reason instead of by tradition and custom.

The author gives an interesting account of the philosophical schools at Athens, which were established by law as religious corporations with regular endowments; and he shows clearly that during most of the period under review they were highly respected and influential.

The intellectual life of the Hellenic world is treated by the author with considerable fullness. The history of physical and mathematical science is omitted, on the ground that the author lacks the special knowledge requisite for treating it. In art the Rhodian and Pergamene schools are of course the most conspicuous; and Mr. Mahaffy shows, that, though this was an age of decadence, the number of excellent artists was by no means small. In literature, after the decline of the New Comedy at Athens, the chief interest centres in Alexandria. The establishment of the Museum and the great library in that city, and the liberal patronage of both by the Ptolemies, made the place the chief seat of literature, as it afterwards became of philosophy. Of the quality of this literature, Mr. Mahaffy expresses the opinion usually held of it by modern scholars. It was distinguished by erudition and imitation of earlier models rather than by original genius or power of style. It is worthy of note, however, that it was at Alexandria that the practice arose of writing poems, and afterwards prose fictions, on the theme of romantic love, — a theme which has since become the most prolific in literature.

The concluding chapter of the book gives an account of the introduction of Hellenic civilization into Rome consequent on the conquest of Greece by the Roman arms; but the subject is only just introduced, as the author intends writing another work on the spiritual life of Hellenism in the Roman Empire. Those who have read his other works will look with interest for the promised volume.

Mount Taylor and the Zuñi Plateau. By Capt. C. E. DUTTON. Washington, Government. 4°.

STUDENTS of American geology who have learned to expect in Captain Dutton's contributions important results ably elaborated, and presented in a style which is simply fascinating, — clear and graphic, and worthy of the geological wonderland in which it has been his fortune to work, — will experience no disappointment in this paper. The district to which it relates (longitude 107° to 109°, and latitude 35° to 36°) lies in the western part of New Mexico, and in the south-eastern corner of the great plateau country, and embraces two distinct geological problems of the first order, — the volcanic region of which Mount Taylor is the culmination, and the Zuñi Plateau. Captain Dutton's previous studies, as well as those of Gilbert, Powell, and others, were confined mainly to the western side of the plateau province, and especially to the portion traversed by the Grand Cañon of the Colorado. But although no geologist possessing any breadth of comprehension could enter the plateau country, and, after gaining an extended knowledge of its physical features, fail to perceive that it is a great unit, and sharply delimited from every thing which surrounds it, it was still extremely desirable to study the south-eastern extensions of these vast masses of strata and the features carved out of them, in the hope that problems which could be only half solved on one side of the plateau could be completely solved on the other. It was felt that the history and evolution of this unique region could be ascertained satisfactorily only by knowing the whole. The survey, therefore, embraced the first opportunity of attacking it from the eastern side; and the admirable monograph before us sufficiently attests the wisdom of this policy.

With the view of putting this new field at once into its natural relations with the whole of which it forms a part, Captain Dutton begins with a summary account of the plateau country in its entirety. The area of the plateau country, south of the Uinta Mountains, is about one hundred and thirty thousand square miles. A shaded map shows its form and its position with reference to the other portions of the western United States. The topographic features and extraordinary scenery of this region have been described many times, and it is deemed needless to descant upon them; but several pages are devoted to the general geologic features underlying these wonderful reliefs. The strata are normally approximately horizontal; and such slight inclinations as occur are very persistent, car-

rying the strata from very high altitudes to very low ones. But no structural features of the plateau country are more truly characteristic than the monoclinical folds and faults.

The marginal portions of the plateau country abound in volcanic rocks and extinct volcanoes, while they are almost wholly wanting in the great central areas. The eruptions vary in age from the middle eocene almost to the present, the latest being probably less than three centuries old. This volcanic border is so nearly complete, that, if a geologist were making the circuit of the plateau province, he could so shape his route that for three-fourths of the way he would be treading upon eruptive materials, and pitch his camp upon them every night.

The classic group of laccolites known as the Henry Mountains is situated in the northern plateaus, and it is now known that this highly interesting type of eruption has been repeated at various points in the province. But perhaps no geological feature of the plateaus is of greater interest in connection with this monograph than the 'swells,' of which the San Rafael 'Swell' is the type; for the Zuñi Plateau is a noble example of this structure. There is a considerable number of swells in the plateaus, and they are of great importance by reason of their association with the most impressive features of the region. They are the localities of maximum erosion, — the centres from which the dissolution of the strata, through the wasting of their edges, has proceeded outwards, in ever-expanding circles, one bed or formation following another, until thousands of feet in thickness, and thousands of square miles in area, have been swept away. Along with this denudation has occurred a doming-up of the strata into a broad, gently swelling boss.

Captain Dutton's beautiful colored map, and the accompanying sections, bring out the topographic and geologic features of the region to which this monograph especially relates with wonderful distinctness. They show that the Zuñi Plateau is simply a great swell in a vast regional expanse of mesozoic rocks, breaking for a brief space the continuity of that system of strata, and presenting a well-marked monocline on either flank, a long, gentle slope of the strata on the north-east, and a short, abrupt slope on the south-west. From its broad surface the mesozoic has been denuded, leaving the edges of the strata, more or less upturned, to face it round about on all sides in rainbow cliffs. Away from the plateau the strata resume their normal horizontality, and the cretaceous becomes again everywhere the surface of the land. Vast and imposing is the expanse of this mighty cretaceous system. If we could rise in a captive balloon two thousand feet above the Zuñi Plateau, the radius of vision would embrace more than twenty thousand square miles covered with it. Yet this is but a trifle in comparison with its whole extent, which embraces half of the North American continent. Its thickness is equally matter of wonder. Whence came this stupendous mass of material? This is undoubtedly one of the most important and difficult questions in American geology.

North-east of the Zuñi Plateau, beyond the noble valley of the San José, rises Mount Taylor. It is a large volcanic cone planted upon a lofty and very extensive mesa of cretaceous strata heavily sheeted over with lava, the lava-cap being seldom less than three hundred feet thick. The cone occupies but a small part of the high platform on which it stands. It is merely the focus and culminating point of a rather large field of volcanic action. It is also clear that the immense cap of lava did not all come from this main orifice, but that the greater part was disgorged from numberless vents scattered over its entire surface, both the concentrated and the diffuse types of volcanic action being well exhibited in the same tract.

The great mesa on which Mount Taylor stands is only one of a series, and it forms only a small part of a great volcanic field. From its southern and eastern margins other mesas of similar composition are plainly visible; and it is certain that the sheet of lava once extended, perhaps without a break, across the broad intervening valleys of erosion, for they are now thickly studded with volcanic necks. These necks are ancient vents which have been exposed and left in striking relief by the wearing-away of the softer cretaceous strata over which their flows once spread. They form one of the most interesting and instructive features of the region, and Captain Dutton has described and illustrated them in considerable detail. It is impossible to follow him further in these interest-

ing descriptive chapters; but we must pass on to the general conclusions.

In the stratigraphy of the plateau country there is no fact of greater importance than the general if not complete absence of Devonian and Silurian strata below the carboniferous. In the Grand Cañon of the Colorado the carboniferous beds rest directly and conformably upon the Cambrian; and in the Zuñi Plateau the Cambrian is also wanting, and they repose upon the Archæan. But, although we thus have evidence of considerable areas of dry land in the Far West before carboniferous time, the strata of the latter age present, except where interrupted by subsequent erosion, one almost universal sheet of marine sediments over the whole western country.

The whole tenor of the evidence accords well with the inference that the surface of the plateau country during the Jura-Trias coincided very nearly with sea-level, but was continually oscillating from a little above to a little below that level, and *vice versa*. This is proved by the character of the sediments and the numerous unconformities by erosion, only without any discordance of dip. At one time it was a land area, sustaining a great forest vegetation, through which many species of dinosaurs wandered; at another it was overflowed by the ocean, and received deposits of fine sand, clay, and gypsum. Whatever may be the true explanation, it is a most extraordinary fact that three thousand to four thousand feet of strata were accumulated upon an area of over ninety thousand square miles, and yet the surface of deposition was maintained throughout at approximately the same level.

Very similar considerations are presented by the cretaceous system. As in the Jura-Trias, there were alternations of land and sea; and whenever the sea withdrew, the land thus laid bare bloomed with forests and swarmed with dinosaurs. Here we find, for the first time in the West, conditions favorable for the formation of coal. From top to bottom the shaly beds of the cretaceous include coal-seams and carbonaceous layers, while the intervening beds abound in fossil leaves. The carboniferous age of the Appalachians repeated itself here in the closing stages of the mesozoic, and upon a scale of equal if not greater grandeur.

An interesting question arises here. How does it happen that coal did not form in the Western Trias also? That vegetation was exuberant in that age is fully attested by the enormous abundance of fossil plants, which are usually silicified. The problem still awaits solution, but certain it is that the Jura-Trias has never yielded in the West a trace of carbonaceous matter. Its trees and shrubs have turned into stone instead of coal.

The source of the detritus forming the mesozoic strata of the West is found chiefly in the Great Basin of Utah, Nevada, etc. The fact is general that these strata grow thinner from west to east, indicating a western origin for its sediments. But the stupendous volume of the sediments in the United States and British America also indicates that they came from a source which was much more extensive than any island; in short, from some continental area, including the Great Basin, and having a shore-line many hundreds of miles long, with numerous large rivers discharging sand and silt.

The movements which ultimately isolated the plateau province, and gave it its distinctive history and development, began in the Laramie period; and during eocene time its area was a vast inland lake with an outlet. In this lake eocene sediments were deposited to a maximum thickness of five thousand feet toward the north, and thinning southward, indicating that they were derived mainly from the Rocky, Uinta, and Wasatch ranges, which were then in existence. The plateau lake finally disappeared in the miocene period, and thus closed the long period of almost continuous deposition which began in early carboniferous time, and during which from ten thousand to fifteen thousand feet of sediments were accumulated.

All this region proclaims an ancient erosion far more vigorous than the present. This is seen in the wide, eroded valleys, fit for the passage of great rivers, but vacant now of flowing waters, their troughs half filled with alluvium, and the grass growing over their flood-plains. We are obliged to refer this erosion to the miocene, and the great elevation of the country which followed it probably occurred during the pliocene.

The elevation of the Zuñi Plateau was attended by the marked bulging or protrusion of limited portions of the Archæan mass carrying up with them the overlying sediments, and forming Mount Sedgwick and other elevations borne upon the plateau. The forms of these granite bosses, as well as the remarkable metamorphism of the immediately overlying carboniferous sandstone, would seem to suggest very strongly that they may be true laccolites. And this view relieves us of the necessity of accounting for the softening *in situ* of the Archæan so near the surface, since these bosses can never have been covered by more than ten thousand feet of strata. There is evidence that the basic eruptions which built up Mount Taylor and the volcanic caps of the mesas were subsequent to some part of the principal erosion of the country, though contemporaneous with a large part of it.

None of Captain Dutton's conclusions will interest the general student more than those relating to the formation of mountains. He traces a series of mountain forms from the extreme simplicity of structure disclosed in the Zuñi Plateau to the comparatively complex structure of the Wasatch and Basin ranges, and finds a generic idea running through them all. It is the idea that was taught us when we were school-boys, that mountains consist of granitic or metamorphic cores, with sedimentary strata upturned upon their flanks.

"Within the past twelve or fifteen years it has become a widely accepted view among the geologists of Europe and America that the forces which have elevated mountains are derived from the strains set up in the outer envelopes of the earth by the secular cooling and shrinkage of its interior; but it should be borne in mind that geological science has flourished most in those countries where the best known and most thoroughly studied mountains and ridges are greatly plicated. To the European geologist the Alps and the Jura have always been the most commanding and interesting of orographic structures. To the Briton the highlands of Scotland and Wales have been equally absorbing fields of research, in which the solution of the problem of mountain-building has been attempted. In America geology had its first and most rapid growth in the Appalachian region, and, when it sought fresh fields in the Pacific slope, it first found them in the Coast Ranges and in the Sierra Nevada. All of these regions are more or less plicated; and it is not to be wondered at that a universal conviction should have grown up that plication and mountain-building are only different names for one and the same thing, or that the process which built the mountains folded the strata at the same time. But as soon as the geologists penetrated the vast mountain-belt which lies east of the Sierra and west of the Great Plains, and proceeded to a careful study of the forms there presented, a wholly different state of affairs was revealed. Not a trace of a systematic plication has yet been found there. The terms 'anticlinal' and 'synclinal' have almost dropped out of the vocabulary of the Western geologist. The strata are often flexed, but the type of the flexure is the monocline."

"The Rocky Mountain region discloses whatever it has to tell us about physical geology with marvellous clearness and emphasis, but there is no teaching more clear or more emphatic than the absence of plicating forces from among the agencies which have built its magnificent ranges and hoisted its great plateaus. They have been lifted by vertical forces acting beneath them. The country at large shows no traces of a widespread, universal, horizontal compression; on the contrary, it discloses the absence of such stress."

These statements are undoubtedly correct, so far as the paleozoic and later formations, and the existing reliefs of the West, are concerned; and Captain Dutton probably did not intend that they should be applied to the Archæan strata of that region, since these are everywhere as strongly plicated as the rocks of any district on the globe. When these ancient crystalline schists of the Rocky Mountain region were folded up, mountains of the Appalachian type must have been formed. But these were largely swept away by erosion before the beginning of the grand cycle of events which Captain Dutton has outlined.

NOTES AND NEWS.

At a meeting of the Biological Society of Washington, Dec. 17, an interesting paper was read by Mr. C. L. Hopkins on the sense of

smell in buzzards. This much-debated point was strongly set forth by Mr. Hopkins relating his experience in Florida. It was the uniform testimony of the Florida 'crackers' that buzzards obtained food by smell. He observed that buzzards never left their roosts on damp, foggy mornings until the ground and shrubbery were dry. They would then move slowly across the wind until a scent was struck, when they would work up the wind until the carrion was found. Sometimes they would drift down the wind, past their prey, until they struck the scent, which would be followed up, finding the object of their search sometimes in the densest scrub. He had on several occasions killed wild hogs in the scrub, and after dressing them, and taking what meat he wished, would see twenty or more buzzards coming down with the wind. On several occasions, covered offal had been detected by them. They had also discovered a buried snake. Several other instances were related, which, in Mr. Hopkins's opinion, conclusively proved that buzzards find some of their food by scent, though that did not preclude the possibility or probability that they obtain other food by sight.

—An interesting event took place at the Perkins Institute for the Blind at South Boston on Dec. 21. It was the celebration of the fiftieth anniversary of the entrance into that institution of Laura Bridgeman, the famous blind deaf-mute. Her first instructor, Dr. Samuel G. Howe, is long since dead; but his wife, Mrs. Julia Ward Howe, presided at the reception. The phenomenal education of Miss Bridgeman will always remain a monument of pedagogic skill. She lost her sight and hearing when two years old, and her taste and smell are both very defective. She speaks by making the manual signs of the deaf-and-dumb, and reads the similar motions of the 'speaker' by feeling the letters as they are formed. She does this with marvellous rapidity, and all the addresses were interpreted to her as they were delivered at the reception. Among the speakers were Dr. Edward Everett Hale and Dr. Phillips Brooks.

—The only railway extending into the Arctic zone runs north from the port of Lulea, in Sweden, at the head of the Gulf of Bothnia, toward the iron-mines of the Gellivara Mountains. The first train to cross the Arctic circle passed over this road a few weeks ago.

—Mr. J. A. Brashear gave an exhibition at his works, Allegheny, Penn., on Dec. 8, 9, and 10, of the large star spectroscope designed and constructed for the Lick Observatory, Mount Hamilton, California.

—The secretary of the committee for the organization of the American Folk-Lore Society, W. W. Newell, Cambridge, Mass., announces that the society will organize in a meeting to be held on Jan. 4 in Cambridge, Mass. The number of members amounts at the present time to two hundred, and, as the society has thus obtained an income sufficient to support a journal, it will begin work. The plan of organizing a society of this kind must recommend itself to all interested in the science of man. The scope of the society's work will be the study of the relics of Old English folk-lore, the lore of negroes in the Southern States of the Union, lore of the Indian tribes of North America, and that of French Canada, Mexico, etc. Furthermore, the study of the general problems of folk-lore, and publication of the results of special students in this department, will form one of the objects of the society. Our country is particularly adapted to the study of certain problems connected with folk-lore, such as the development of European and African lore in a new environment, and the origin of a new lore in mixed races. The material furnished by such researches is of prime importance for a study of the psychology of nations. It is hardly necessary to emphasize the fact that the collection of the rapidly vanishing remains of Indian folk-lore must be carried on vigorously, and on an intelligent plan, else it will be too late. The publications of the society will undoubtedly contain a vast amount of interesting material, and will amply repay the annual fee of three dollars. Our knowledge of the subject of American lore is still so slight, that almost any one who comes into contact with Indians, negroes, or the less educated white men, can make valuable contributions to this science; and therefore we would wish that the membership of the new society were thousands instead of hundreds.